

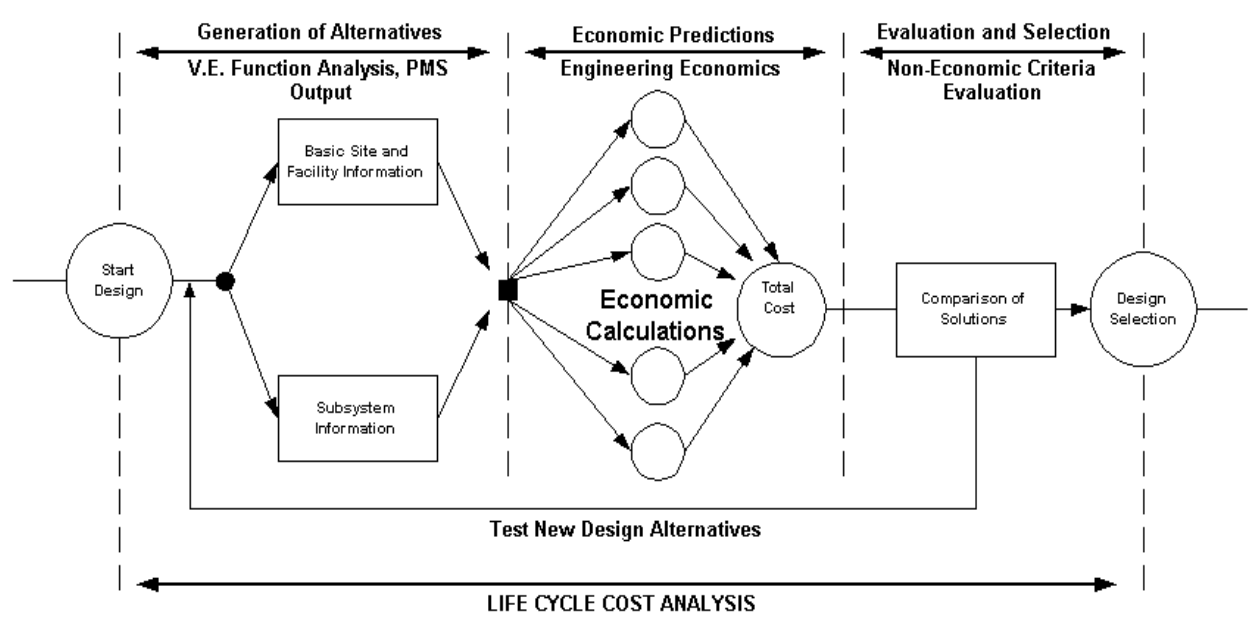
Section 1003 PROCEDURES

1003.01 Generating Alternative Designs

The previous sections discussed cost factors and the economics of life cycle cost analysis. This section puts all that together, explaining the process to complete the analysis using a decision to construct or rehabilitate a pavement. First, identify all alternatives meeting design requirements. Alternative examples for a new pavement are bituminous or portland cement concrete and for rehabilitation, conventional overlay, recycling, placing a fabric or rubber interlayer before resurfacing, and removing and replacing the existing surface. The surface condition drives the rehabilitation alternatives.

A thorough understanding of problems and design parameters is essential to start the process. Next, identify unique site characteristics. Then, using the Pavement Management System's design alternative outputs as well as those alternatives which may not be included for projects exhibiting special conditions. Pavement Management Systems can use many different methodologies for the generation of alternatives, all of which can be reliable. Finally, don't forget the alternative of not taking any action. Figure 3 illustrates the relationship between LCC analysis and value engineering.⁵

AASHTO defines value engineering as "analysis of materials, processes, and products in which functions are related to cost and from which a selection may be made for the purpose of achieving the required function at the lowest overall cost consistent with the requirements for performance, reliability, and maintainability; sometimes called Value Analysis."¹



An organized problem-solving effort, value engineering analyzes the various functions of construction, maintenance, rehabilitation, procedures, methods, etc. The objective is to obtain the lowest total cost of ownership consistent with the need for performance, reliability, quality, and maintainability.

After identifying all possible alternatives, a selection of the most promising choices must be made. The following criteria can be used in making this evaluation.²

- (1) Will the idea work? Can it be modified or combined with another?
- (2) What is the life cycle cost savings potential?
- (3) What are the chances for implementation?
- (4) Will it satisfy all of the user's needs?

All alternatives receive at least a preliminary evaluation before elimination. A list of advantages for each alternative helps in cutting down the list. Develop the remaining alternatives with more detail designs and cost estimates. The remaining alternatives must adequately perform all the required objectives, whether efficiently or not. These alternatives now enter design evaluation, including life cycle costing.

1003.02 Design Evaluation

Further reduce remaining alternatives by comparing and ranking the ideas within each alternative. The following will help in the evaluation.

- (1) Ability to perform the function-ratings might be excellent, good, fair, poor.
- (2) Ease of implementation, including cost and schedule-rating might be:
 - a. Simple idea: easy to implement.
 - b. Moderately complex idea: moderately easy to implement.
 - c. Complex idea: difficult to implement.
- (3) Magnitude of savings (initial and life cycle).
- (4) Ranking of alternatives.

Judge advantages, disadvantages, and ideas objectively. Include in this process an estimate of the potential reduction in life cycle costs and how each alternative meets required functions. Develop the remaining alternatives, including more detailed cost estimates. Be as accurate and consistent as possible between alternatives. Consider the following, modified from evaluation criteria listed in "Generating Alternative Designs," during this portion of the evaluation.

- (1) Will the idea work? Can it be modified or combined?
- (2) What is the life cycle savings potential?
- (3) What are the chances for implementation? Will it be relatively easy or difficult to make the change?

- (4) Will it satisfy all the user's needs?

With the preliminary evaluation complete and the best available cost data on hand, the remaining alternatives are ready for LCC analysis using the information and equations listed in "Engineering Economics."

1003.03 Design Selection

Now that the LCC analysis is complete, a final decision can be made. Even though the LCC analysis indicates one specific alternative, other considerations may require a different choice. Factors leading to this other choice that may override economics include traffic, soils characteristics, weather, performance of similar pavements in the area, adjacent existing pavement, stage construction, depressed surface or elevated design, highway system, conservation of aggregates, stimulation of competition, construction considerations, municipal preference and recognition of local industry, traffic safety, and availability of and adaptations of local materials or of local commercially produced paving mixes. AASHTO's "An Informational Guide on Project Procedures" sets guidance in this area.

The Federal Highway Administration (FHWA) developed a Policy Statement on Pavement Type Selection that "is designed to provide the public with acceptable highway service at a minimal annual or life cycle cost while permitting maximum flexibility. This policy encourages the consideration of alternate designs and strategies in the type selection process." This policy is intended for use on both new and rehabilitated pavements.

The FHWA policy states:³

- (1) Pavement type selection should be based upon an engineering evaluation considering the factors contained in the 1960 AASHTO publication entitled "An Informational Guide on Project Procedures."
- (2) Pavement type determination should include an economic analysis based on life cycle costs of the pavement type. Estimates of life cycle costs should become more accurate as pavement management procedures begin providing historical cost, serviceability, and performance data. States without this data are encouraged to obtain it.
- (3) An independent engineering and economic analysis and final pavement type determination should be performed or updated a short time prior to advertising on each pavement type being considered.
- (4) Where the analysis reflects that two or more initial designs and their forecasted performance are determined to be comparable (or equivalent), then alternate bids may be permitted if requested by the contracting agency. The Division Administrator shall review the analysis and concur in the finding of equivalency prior to PS&E approval. Price adjustment clauses should not be used when alternate bids are permitted.

This policy is written with the intention of taking advantage of fluctuating material prices while not compromising good design and pavement management practices.

Before making a final decision, consider the probability of successful implementation and ease of maintenance. A sensitivity analysis should be considered if two alternatives indicate close life cycle costs. This verifies the final choice as still the low cost even when input variables or

conditions change slightly.

1003.04 System Updating

The selection of an alternative and its implementation does not end the process. Continual review of costs and performance should be made. Update procedures based on this review. Alternatives selected on the basis of LCC analysis require periodic review to ensure response follows the planned approach.

1003.05 Examples

See Appendix B for examples illustrating the complete Life Cycle Cost analysis process as it applies to the Utah Department of Transportation. These examples illustrate life cycle cost techniques used in comparison of alternatives for transportation projects. Sensitivity Analysis is shown for each example, with a graphical depiction of the resultant findings.

1. American Association of State Highway and Transportation Officials, *AASHTO Highway Definitions*, Special Committee on Nomenclature, AASHTO, Washington, D.C., 1968.
2. Kirk, S.J., "Life Cycle Costing: Problem Solver for Engineers," *Specifying Engineer*, 1979.
3. Federal Highway Administration, "Pavement Type Selection; Policy Statement," *Federal Register*, Vol. 46, No. 195 and "Pavement Type Selection; Policy Statement; Clarification," *Federal Register*, Vol. 46, No. 216; 23 CFR Ch. 1, Department of Transportation, Federal Highway Administration, Washington, D.C., 1980.